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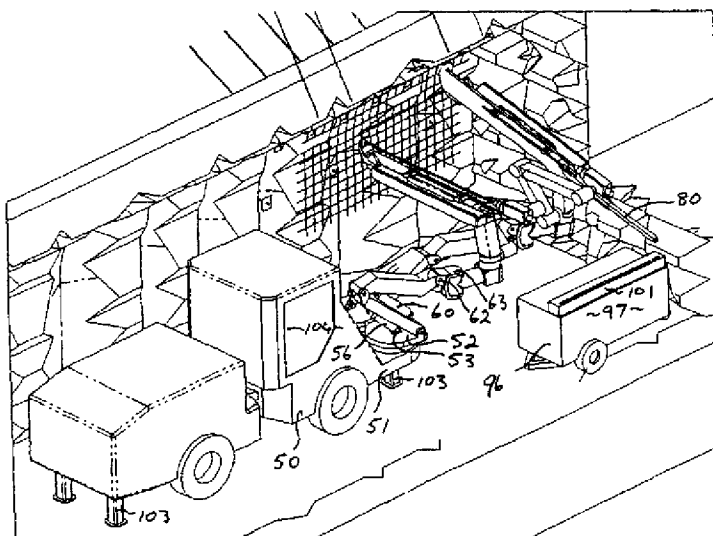
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(54) Title: **ROCK-BOLTING APPARATUS AND METHOD**



(57) Abstract: An articulated boom arm for a rock boring machine, comprising a first kinked member having a drill guide at one end and a base pivot at the other end, and a pair of pivoted links. One of said links having a first end pivoted at said base pivot, the other of the links having a drill pivotally mounted at a first end thereof. The second ends of the first and second links being pivoted to each other whereby said drill is reciprocally linearly movable along said first member with a drill bit aligned with said drill guide and at one extremity of the reciprocal movement both said pair of links are substantially longitudinally aligned and extend towards said drill guide, and at the other extremity of the reciprocal movement both said pair of links are substantially longitudinally aligned and extend away from said drill guide.

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ROCK-BOLTING APPARATUS AND METHOD

TECHNICAL FIELD

This invention relates to a rock-bolting apparatus and method.

5 This invention has particular but not exclusive application to a rock-bolting apparatus and method for use in mine construction, and for illustrative purposes reference will be made to such application. However, it is to be understood that this invention could be used in other applications, such as general tunnel construction, underpinning and the like.

10 BACKGROUND

Underground mining of mineral ores, such as coal and hard and soft rock mining requires the 'development' of underground drives in the form of tunnels. In all hard-rock applications, drive development is achieved through a drilling, charging, blasting, and mucking cycle. In the drilling stage of the cycle, a pattern
15 of holes is drilled into the blind end of the drive. The holes are generally parallel to the drive axis. Typically, holes are 2-4 metres deep.

In the charging stage, explosive is placed in the drilled holes and connected via a detonating arrangement. In the blasting stage the explosive is detonated, the resulting blast fracturing the solid rock. In the mucking stage a
20 front-end loader digs the fractured rock and removes it for hoisting to the surface via skips. This development cycle is well understood and is currently the most cost effective means of developing drives in hard rock.

An unavoidable consequence of this proven method is rock fracture beyond the desired geometric shape of the tunnel cross-section. This rock
25 fracturing can cause the tunnel roof or back and/or the drive's side-walls to be unstable. Rock fragments large and small can disengage from the back and sidewalls and fall under the influence of gravity. Particle size ranges from microscopic to cubic metres. Falling particles larger than a tennis ball can prove fatal to personnel.

To protect miners from larger falling particles, a rock bolting/meshing procedure is applied. The process requires drilling holes 2-4 metres long in the 'back' (walls and overhead), and holding square mesh, typically 50mm x 50 mm to 150 mm x 150 mm apertures, against the 'back'. Rock bolts and retaining
5 plates are inserted through the mesh and into the drilled holes. Larger particles are restrained from falling by the rock-bolts and smaller particles are retained or caught by the mesh.

Rock bolts come in various styles and each style is available in a range of lengths. Common styles include the split set type where long slotted tubes grip
10 the drilled hole via radial springing action along the entire length of the bolt. These bolts rust away in time and jeopardize long-term security. The wedge-lock type is a bolt with an expanding tip, the locking action being controlled by screwing action. The gripping is at the blind end of the hole only. These bolts also rust away in time and jeopardize long-term security. Epoxy grouted systems
15 utilize a two-pack epoxy sausage which is inserted into the drilled hole. The bolt is inserted via a rotating action that mixes the epoxy. Curing is rapid usually taking about 35-60 seconds. In such epoxy grouted systems gripping occurs substantially along the entire length of the bolt/hole. These epoxy grout system bolts resist corrosion. Cement grouted systems are also used.

20 Rock-bolting/meshing equipment comes in two broad groups, comprising purpose built drilling bolting machines and adaptations of twin boom development heading 'jumbo' drills. The purpose built drilling bolting machines generally feature three parts, being a transport vehicle subassembly, a multi-axis support arm mounted thereon and a drilling and bolting mechanism on the support arm.
25 The drilling and bolting mechanism contains many functions and is relatively heavy, both for robustness and to provide inertial stability. The multi-axis support arm, while capable of supporting the mechanism, tends to deflect, has low natural frequencies of bobbing up/down and back/forth and also has poor 'fine control'. The transport vehicle is rubber tyred, with articulated steering, diesel
30 powered and with front jacks for vehicle stability while working.

In use, problems arise because of the physical properties of the freshly fractured rock surface. It is uneven and fractured, presenting a myriad of randomly oriented faces. Lighting from the vehicle throws this surface into stark black/white features where the operator cannot determine the inclination of faces to select a stable face for drilling.

Collaring is the step of the drill taking purchase and commencing the new hole and usually describes the first 0-20 mm of drilling. The drill head is a blunt steel arrangement with embedded tungsten carbide tips, air or water cooled and purged via a central hole along the drill steel. Cutting is by rotation and impact from the drill, with typical drilling speeds being at 1-2 metres per minute. When the blunt drill head strikes an angled rock face in attempting to collar a new hole, it generally cannot achieve penetration. Instead the drill slides down the face until it finds purchase in the 'valley' between two intersecting planes of the rock faces. Collaring now proceeds as does the remainder of the hole drilling.

The drill bit, sliding down the rock face and into the 'valley' demands lateral compliance since the support arm's hydraulics have not yielded or adjusted. Compliance is available from many sources including elastic bending of the drill steel, mechanical play or hackles in the drill steel/drill interface, the drill/drill slide interface and every other mechanical junction, deflection in the supporting arm, and deflection in the supporting vehicle.

The drill achieves a collared and drilled hole, albeit not precisely where the drill was aimed. Upon drill steel extraction from the new hole, the elastic compliance is released and the whole machine wobbles back and forth, finally settling with the drill steel axis no longer aligned with the freshly drilled hole. The mechanism now increments, removing the drill from the axis and replacing it with a bolt magazine with an inserted bolt. The bolt has little chance of finding the hole because the mechanical 'slop' (play, clearance, backlash) is endemic, with machine parts which are expected to operate reliably despite spending their lives in a shower of water, grit and falling rocks. The net effect is that the drilled hole will often not be co-axial with the bolt. Rock fragments often fall from the 'back'

around the freshly drilled hole to sit on the mesh, masking the hole. Attempting to insert an all metal bolt is normally unsuccessful.

The machine operator then gets out of his protected cabin and walks under the unprotected cabin and walks under the unprotected, freshly fractured, freshly drilled ground to try and find the offset error between where the hole axis lies and where the bolt axis lies. This is the most dangerous time with a high risk of falling rock causing death or injury. The operator then goes back to his machine and tries to remember the direction and distance of the offset and, using an arm with poor 'fine control', attempts to adjust for the error. There are often several attempts required to adjust for bolt insertion. With epoxy-grouted bolts, these aiming problems can see the two-part epoxy sausage bursting, covering the drilled/bolting mechanism and/or the hole opening with rapidly setting epoxy, which can disable the mechanism and/or block the hole.

15 SUMMARY OF INVENTION

According to a first aspect the present invention consists in an articulated boom arm for a rock boring machine, said arm comprising a first kinked member having a drill guide at one end and a base pivot at the other, and a pair of pivoted links, one of said links having a first end pivoted at said base pivot, the other of said links having a drill pivotally mounted at a first end thereof, the second ends of said first and second links being pivoted to each other whereby said drill is reciprocally linearly movable along said first member with a drill bit aligned with said drill guide and at one extremity of the reciprocal movement both said pair of links are substantially longitudinally aligned and extend towards said drill guide and at the other extremity of the reciprocal movement both said pair of links are substantially longitudinally aligned and extend away from said drill guide.

Preferably said arm is mounted on a seven axis manipulator assembly, said assembly comprising a turntable rotatable about a first substantially vertical axis, a first arm pivotally mounted to said turntable about a second, substantially

horizontal axis, a second arm pivotally about a third, substantially horizontal axis, a yoke pivotally mounted to said second arm about a fourth, substantially horizontal axis and having a pair of arms defining a fifth axis about which a trunnion is pivoted, and a boom arm base support pivoted to said trunnion about
5 a sixth axis substantially perpendicular to said fifth axis, said boom arm first member being rotatably mounted to said base support about a seventh axis substantially perpendicular to said sixth axis.

Alternatively, a six axis manipulator can be provided.

10

Preferably said pair of links can be manipulated between said extremities to provide multiple modes of operation, to provide a longer stroke for blast hole drilling and a shorter stroke for drilling and bolting.

15 According to a second aspect the present invention consists in magazine system for elongate rock bolts having a shaft with a front tip at one end and a drive means at the other end, said system comprising a plurality of said bolts arranged in a substantially parallel array, at least one belt extending substantially transversely to said bolts and having a plurality of spaced receptors each of
20 which accommodates a corresponding bolt; and a housing for said magazine having a length exceeding the length of said bolts.

In one embodiment said belt is arranged in serpentine fashion within said housing to permit said bolts to be sequentially removed from said housing but
25 retained in said parallel array.

In another embodiment said belt is arranged in a radial fashion within said housing to permit said bolts to be sequentially removed from said housing.

30 Preferably said receptors are substantially equally spaced apart.

Preferably where two of said belts are provided, said belts being longitudinally spaced apart relative to said bolt shafts.

Preferably said at least one belt is disintegratable.

5

Preferably washer plates adapted for use with said bolts are stored in stacked relationship in a separate magazine housing away from said bolts.

According to a third aspect the present invention consists in a dispensing device
10 for steel reinforcing mesh, said device comprising a roll of said mesh mounted to permit unrolling movement of said mesh about the longitudinal axis of said roll, the free end of said roll passing between straightening rollers arranged to increase the radius of curvature of said mesh on passing therethrough, and mesh severing means located downstream of said rollers to cut the at least partially
15 straightened mesh to length.

Preferably said device is mounted on a wheeled carriage.

According to a fourth aspect the present invention consists in a method of
20 applying steel reinforcing mesh to a tunnel or drive, said method comprising the steps of:

- (i) unwinding a length of mesh from a roll thereof;
- (ii) at least partially straightening said length of mesh to increase the radius of curvature thereof;
- 25 (iii) cutting said at least partially straightened mesh to suit the peripheral dimensions of said tunnel or drive;
- (iv) securing said cut length of mesh to said tunnel or drive periphery with rock bolts or equivalent securing devices; and
- (v) repeating steps (i) – (iii) above and then securing the newly cut
30 length of mesh adjacent the previously secured length of mesh.

Preferably said tunnel or drive has a floor and a substantially arch shaped roof and side walls and said mesh is applied to said roof and side walls only.

BRIEF DESCRIPTION OF THE DRAWINGS

5 The invention will be further described with reference to the drawings illustrating a preferred embodiment of the present invention and wherein:

FIG. 1 is a perspective view of an alternative embodiment of apparatus in accordance with the present invention, in use;

FIG. 2 is a further perspective view of the apparatus of FIG. 1, in use;

10 FIGS. 3A-C is a partial perspective view of the apparatus of FIG. 1, showing sequential deployment of the drilling assembly;

FIG. 4 is a partial perspective view of the apparatus of FIG. 1, showing deployment of the drilling assembly;

15 FIG. 5 is a partial perspective view of the apparatus of FIG. 1, showing deployment of the bolting magazine assembly;

FIGS. 6A-G is a partial perspective view of the apparatus of FIG. 1, showing sequential assembly of the slewing primary arm assembly;

FIGS 7 A-C are sequential side views illustrating short drilling/bolting operation of the boom/drill means of the apparatus of FIG. 1;

20 FIGS. 8 A-D are sequential side views illustrating long drilling operation of the boom/drill means of the apparatus of FIG. 1;

FIG. 9 is a perspective view of the apparatus of FIG. 1 deployed for blast hole drilling using the long drilling operation of FIG 8;

25 FIGS. 10A-C is a partial perspective view of the apparatus of FIG. 1, showing sequential deployment of bolt magazines;

FIG. 11 is a perspective view of linked bolts and magazine for use in the apparatus of FIG. 1;

FIG. 12 is an end detail view illustrating the packed configuration of the bolts and magazine of FIG. 11;

FIG. 13 is a view of the washer plate and magazine assembly for use in the apparatus of FIG. 1;

5 FIGS. 14A-E are sequential illustrations of operation of a mesh magazine suitable for use in the apparatus of FIG. 1; and

FIGS. 15 A-B are perspective and plan view illustrations of the dynamic properties of the apparatus of FIG. 1 in its stowed configuration.

10 MODE OF CARRYING OUT INVENTION

In the embodiment illustrated in FIGS 1 to 15, there is shown a rock bolting apparatus in accordance with the present invention having a twin-boom jumbo chassis forming carriage 50. Machinery platform 51 of carriage 50 mounts a pair of slewing bases 52. The slewing bases 52 each have a pair of spaced
15 hard points 54 for pivotally mounting a primary arm lower member 55, the relative disposition of which is provided by a ram 56 disposed between lower member 55 and a third hard point 53 on slewing base 52. A primary arm upper member 57 is hinged to lower member 55, and the relative disposition of the upper member 57 and lower 55 members is controlled by a ram 60 disposed between the upper
20 and lower arms.

The upper and lower arms operate in a vertical plane that can be slewed via the slewing base. A yoke 61 is pivoted to the outer end of the upper member 57 via a yoke pivot 62 having an axis substantially parallel to the articulation between the upper and lower members. The yoke 61 includes a trunnion portion
25 63 having a trunnion axis substantially perpendicular to the yoke pivot 62.

Articulated in the trunnion portion 63 is a tool mounting base assembly 64 including a tool mounting base 65 having a first mode of rotation in a plane parallel to the trunnion axis and a second mode of rotation in a plane perpendicular to the trunnion axis.

A tool assembly 66 is supported on the tool mounting base 65 and comprises a common base portion 67 extending integrally into a boom body 70 and further mounting a power head assembly 71.

The boom body 70 has a forward end mounting a drive wall engagement portion 72 having an aperture (drill guide) 73 therethrough of dimension adequate to pass drills and bolts. The wall engagement portion 72 includes a pair of spaced wall engaging ridges 74 disposed about the aperture 73 and defining therebetween a channel 75. The channel 75 is in index with a washer plate magazine 76 disposed below the wall engagement portion 72 and is operable whereby a washer plate 77 may be displaced from the magazine 76 into the channel 75 and into register with the aperture 73.

The boom body 70 further comprises a housing for a telescopic rear strut 80 which is adapted to be deployed to engage the drive wall opposite to the wall engagement portion 72 and thereby brace it into engagement with the drive wall during the drilling and bolting operations.

The boom body 70 has mounted thereon a tool and bolt handling assembly 81 comprising a pair of shaft mounted gripper arms 82 adapted to selectively engage either of a short 84 drill bit a rock bolt 85 or a conventional epoxy or grout tube (not shown). The rock bolts 85 are presented to the gripper arms by bolt magazine housing 86 removably supported on the boom body 70 and having mounted therein a belt 87 comprising plurality of bolts 85 held together by links 90 in a substantially parallel array, whereby the bolts 85 may be sequentially disintegrated from the belt 87 by the gripper arms 82. Belt 87 has plurality of spaced apart receptors each of which accommodates a corresponding rock bolt 85, and is arranged in serpentine fashion within magazine housing 86. The belt 87 is preferably a rubber link belt or webbing belt or other pliant material, such as interconnected rigid links.

The power head assembly 71 comprises a drifter (percussion drill) 91 pivotally mounted on a two-link tool arm 92 pivoted to the common base portion 67 whereby the drifter 91 may be selectively deployed along a line parallel with

the boom body 70 (and drive wall engagement portion 72) and having its longitudinal axis aligned with the aperture (drill guide) 73. The two-link tool arm 92 has an intermediate elbow 93 that may be deployed forward of the common base portion 67 to commence a short throw of the drifter 91 for drilling and
5 bolting, and behind the common base portion 67 to commence a long throw for drilling blast holes in the advancing drive face 94, as illustrated in the respective sequences of FIGS. 7 and 8. A view of the drive face drilling operation is also provided in FIG. 9.

An advantage of the present embodiment is that the washer plates 77 are
10 stored separately in magazine 76 away from belt 87 of rock bolts 85. In the prior art the rock bolts are housed in magazines with washers attached and therefore take up considerable space.

The drill bit 84 shown in FIG. 7, used for the short throw of drilling and bolting may in one embodiment be about 3m long, whilst the drill bit 83 shown in
15 FIG. 8 used for a long throw for drilling blast holes may be about 5m long.

The drifter 91 is fitted with an automatic chuck 95 adapted to receive in turn either of the drill bits 83, 84 or the rock bolts 85.

A consumables cart 96 comprises a wheel mounted mesh magazine 97 containing a mesh roll 100 that is led out through a feed and cutter assembly
20 101. The boom body 70 is adapted to engage the leading edge of the mesh roll 100 for deployment of the mesh in use. The consumables cart 96 has spare bolt magazines 86 which are collectable by the boom arm 70, as illustrated in the sequence of FIGS. 10A to 10C. The carriage 50 is articulated at 102 in order to optimize the turning circle and maneuverability of the carriage 50, as illustrated in
25 FIGS. 15A and 15B. The carriage 50 includes locating jacks 103 adapted to remove the effect of wheel and suspension compliance on stability when drilling and bolting.

For travel, the slewing bases 52 are aligned with the primary arm lower member 55 and upper member 57 fully retracted in a fore-and-aft vertical plane.
30 The telescopic rear strut 80 is fully retracted into the boom body 70 and the boom

body 70 is rotated about the tool mounting base 65 to extend back in the direction of the carriage cab 104.

In use the apparatus is located for drilling and bolting as illustrated in the sequence of FIGS. 3A to 3C, wherein (after engagement of the jacks 104) the primary arm 55, 56 locates the boom body 70 in concert with the tool mounting base 65 such that the drive wall engagement portion 72 is in contact with the drive wall at the desired position. The telescopic rear strut 80 is then extended to engage the drive wall opposite the drive wall engagement portion 72, thus essentially fixing the boom against movement.

It will of course be realized that while the above has been given by way of illustrative example of this invention, all such and other modifications and variations thereto as would be apparent to persons skilled in the art are deemed to fall within the broad scope and ambit of this invention as is herein set forth.

In other not shown embodiments the shape and configuration of the various components of the rock bolting apparatus may differ from that shown in the abovementioned embodiment. For instance, in one not shown embodiment the magazine housing 86 and/or magazine 76 may be fixed or integral with boom body 70.

Also in another not shown embodiment the belt 87 may be arranged radially in a drum housing rather than in serpentine fashion in a box housing.

Also in another not shown embodiment the aperture (drill guide) 73 may be done away with, and washer plate 77 is moved into place on channel 75 of boom body 70 and also acts as the drill guide instead of aperture 73.

The mesh dispenser 97, straightening rollers and sheering apparatus can, if desired, be carried by the vehicle 50 itself rather than towed as a consumables cart 96.

CLAIMS

1. An articulated boom arm for a rock boring machine, said arm comprising a first kinked member having a drill guide at one end and a base pivot at the other, and a pair of pivoted links, one of said links having a first end pivoted at said base pivot, the other of said links having a drill pivotally mounted at a first end thereof, the second ends of said first and second links being pivoted to each other whereby said drill is reciprocally linearly movable along said first member with a drill bit aligned with said drill guide and at one extremity of the reciprocal movement both said pair of links are substantially longitudinally aligned and extend towards said drill guide and at the other extremity of the reciprocal movement both said pair of links are substantially longitudinally aligned and extend away from said drill guide.
2. An articulated boom arm as claimed in claim 1, wherein said pair of links can be manipulated between said extremities to provide multiple modes of operation, to provide a longer stroke for blast hole drilling and a shorter stroke for drilling and bolting.
3. An articulated boom arm as claimed in claims 1 or 2, wherein said arm is mounted on a seven axis manipulator assembly, said assembly comprising a turntable rotatable about a first substantially vertical axis, a first arm pivotally mounted to said turntable about a second, substantially horizontal axis, a second arm pivotally about a third, substantially horizontal axis, a yoke pivotally mounted to said second arm about a fourth, substantially horizontal axis and having a pair of arms defining a fifth axis about which a trunnion is pivoted, and a boom arm base support pivoted to said trunnion about a sixth axis substantially perpendicular to said fifth axis, said boom arm first member being rotatably mounted to said

base support about a seventh axis substantially perpendicular to said sixth axis.

- 5 4. A magazine system for elongate rock bolts having a shaft with a front tip at one end and a drive means at the other end, said system comprising a plurality of said bolts arranged in a substantially parallel array, at least one belt extending substantially transversely to said bolts and having a plurality of spaced receptors each of which accommodates a corresponding bolt; and a housing for said magazine having a length exceeding the length of
10 said bolts.
5. The magazine system as claimed in claim 4, wherein said belt is arranged in serpentine fashion within said housing to permit said bolts to be sequentially removed from said housing but retained in said parallel array.
15
6. The magazine system as claimed in claim 4, wherein said belt is arranged in a radial fashion within said housing to permit said bolts to be sequentially removed from said housing.
- 20 7. The magazine system as claimed in claim 4 to 6, wherein said receptors are substantially equally spaced apart.
8. The magazine system as claimed in claim 5, wherein two of said belts are provided, said belts being longitudinally spaced apart relative to said bolt
25 shafts.
9. The magazine system as claimed in any one of claims 4 to 8, wherein the at least one belt is disintegratable.

10. The magazine system as claimed in any one of claims 4 to 9, wherein washer plates adapted for use with said bolts are stored in stacked relationship in a separate magazine housing way from said bolts.

5 11. A dispensing device for steel reinforcing mesh, said device comprising a roll of said mesh mounted to permit unrolling movement of said mesh about the longitudinal axis of said roll, the free end of said roll passing between straightening rollers arranged to increase the radius of curvature of said mesh on passing therethrough, and mesh severing means located
10 downstream of said rollers to cut the at least partially straightened mesh to length.

12. A dispensing device for steel reinforcing mesh as claimed in claim 11, wherein said device is mounted on a wheeled carriage.

15 13. A method of applying steel reinforcing mesh to a tunnel or drive, said method comprising the steps of:

- (i) unwinding a length of mesh from a roll thereof;
- (ii) at least partially straightening said length of mesh to increase the
20 radius of curvature thereof;
- (iii) cutting said at least partially straightened mesh to suit the peripheral dimensions of said tunnel or drive;
- (iv) securing said cut length of mesh to said tunnel or drive periphery with rock bolts or equivalent securing devices; and
- 25 (vi) repeating steps (i) – (iii) above and then securing the newly cut length of mesh adjacent the previously secured length of mesh.

14. The method of applying steel reinforcing mesh to a tunnel or drive as claimed in claim 13, wherein said tunnel or drive has a floor and a
30 substantially arch shaped roof and side walls and said mesh is applied to said roof and side walls only.

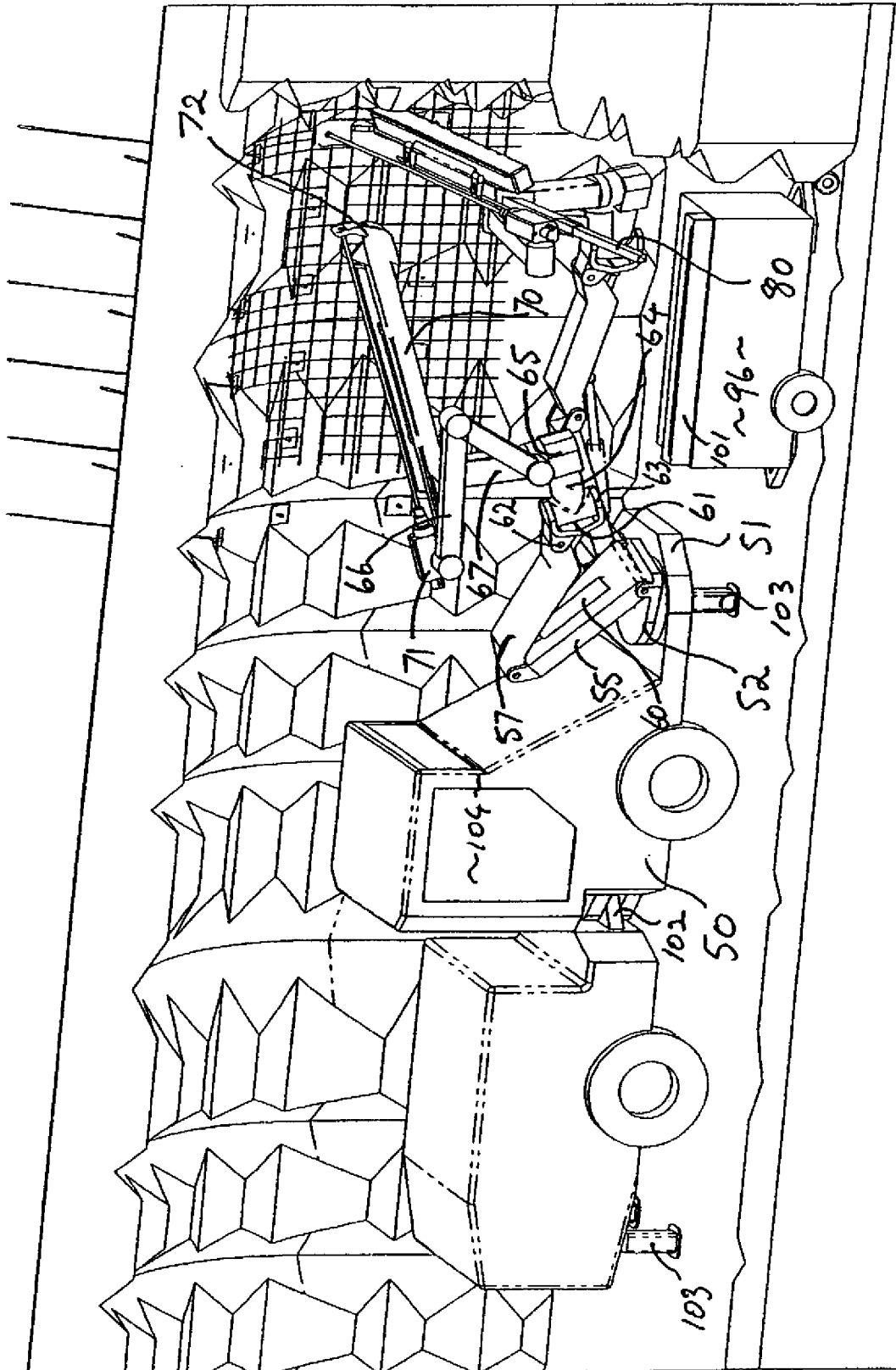


FIG. 1

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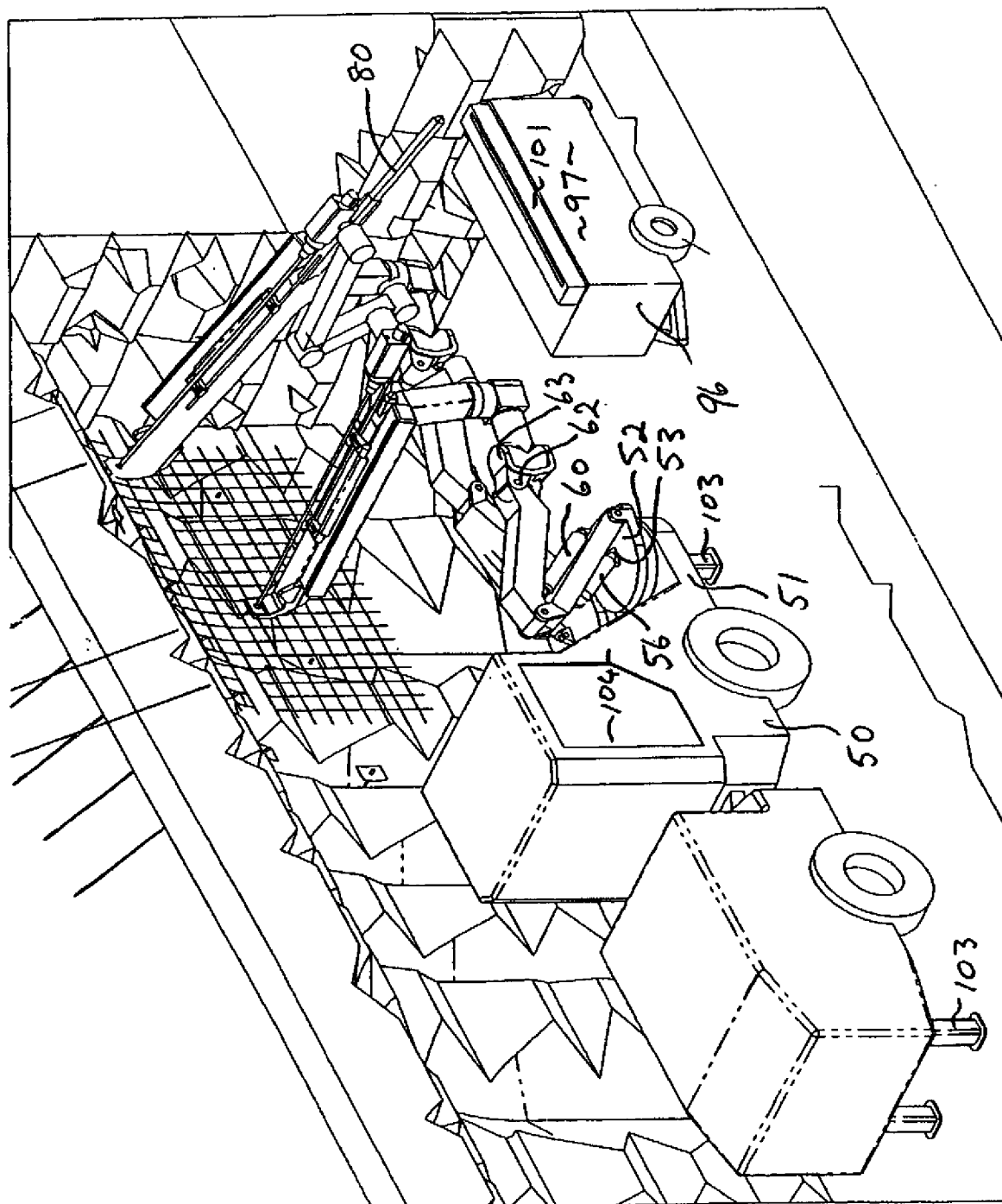


FIG. 2

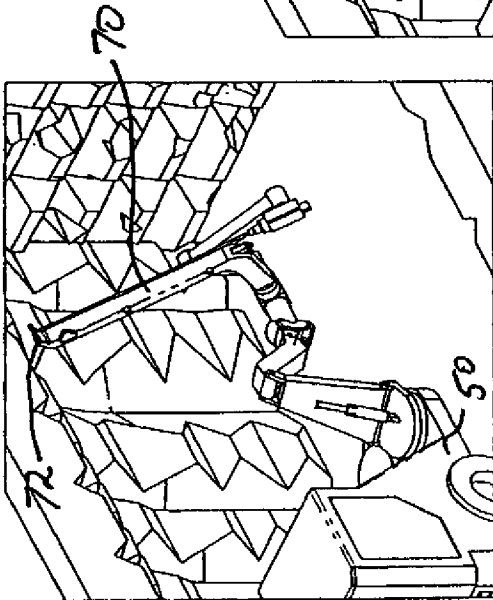


FIG. 3A

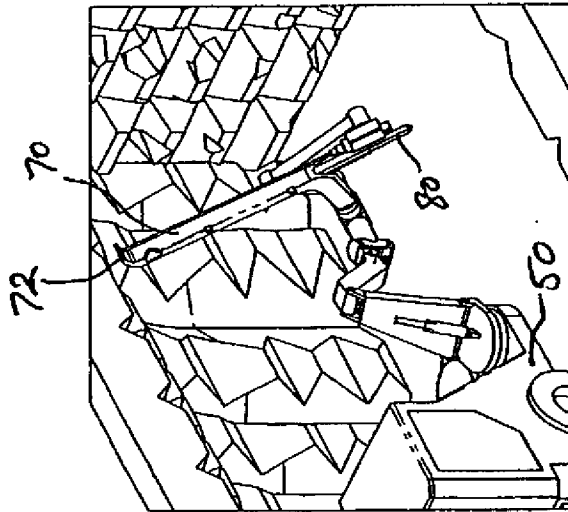


FIG. 3B

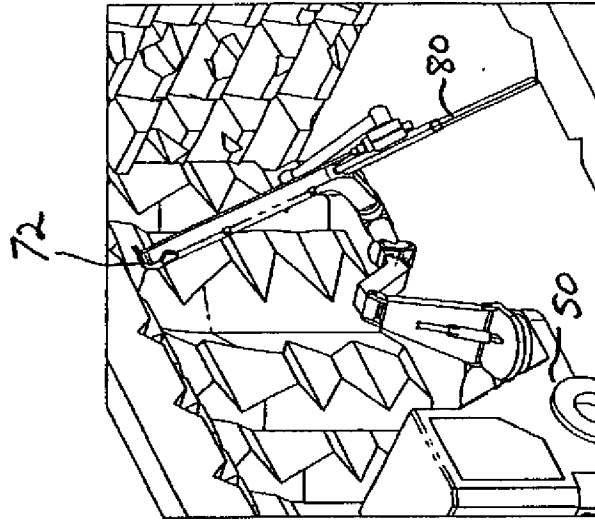
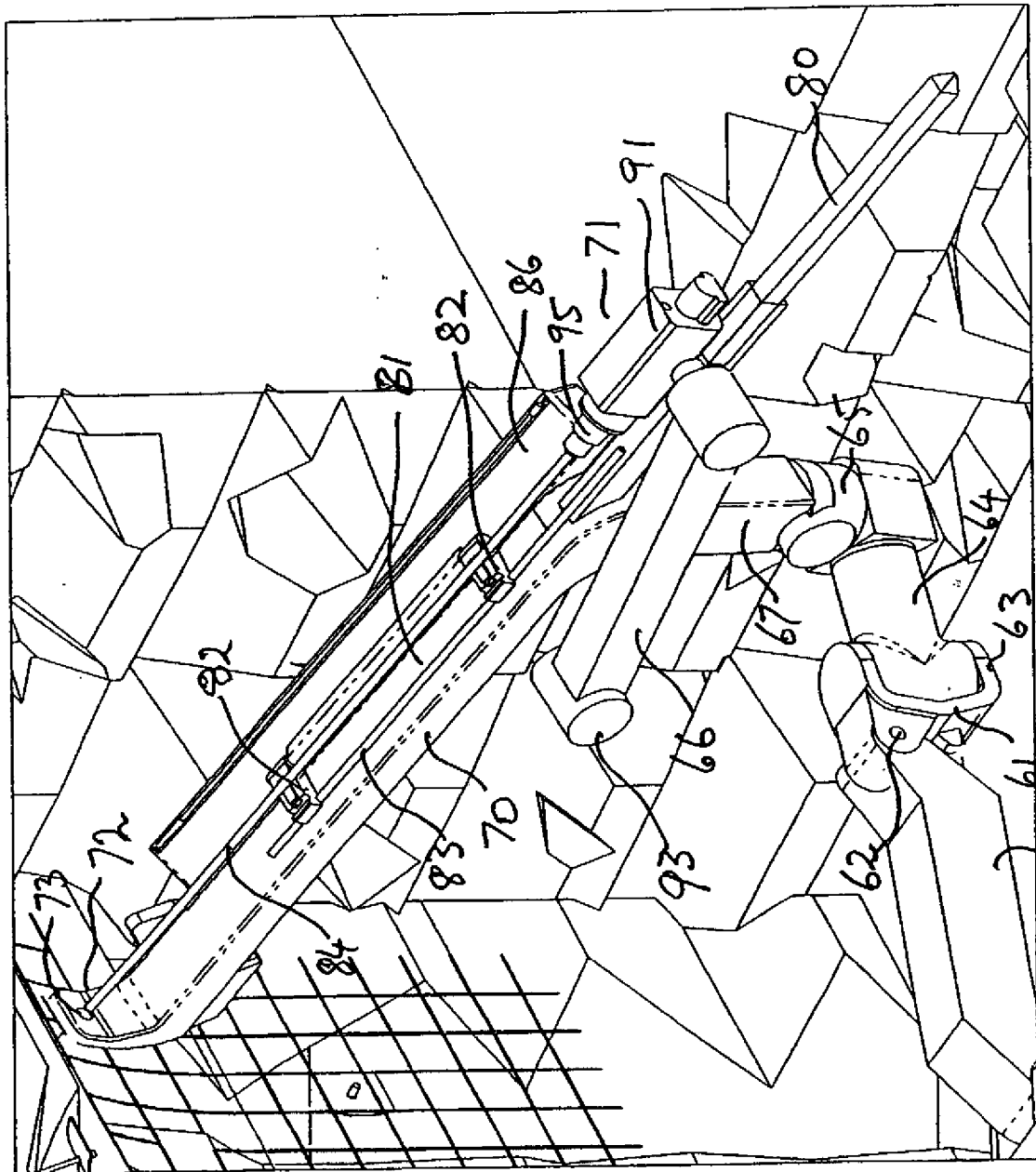


FIG. 3C



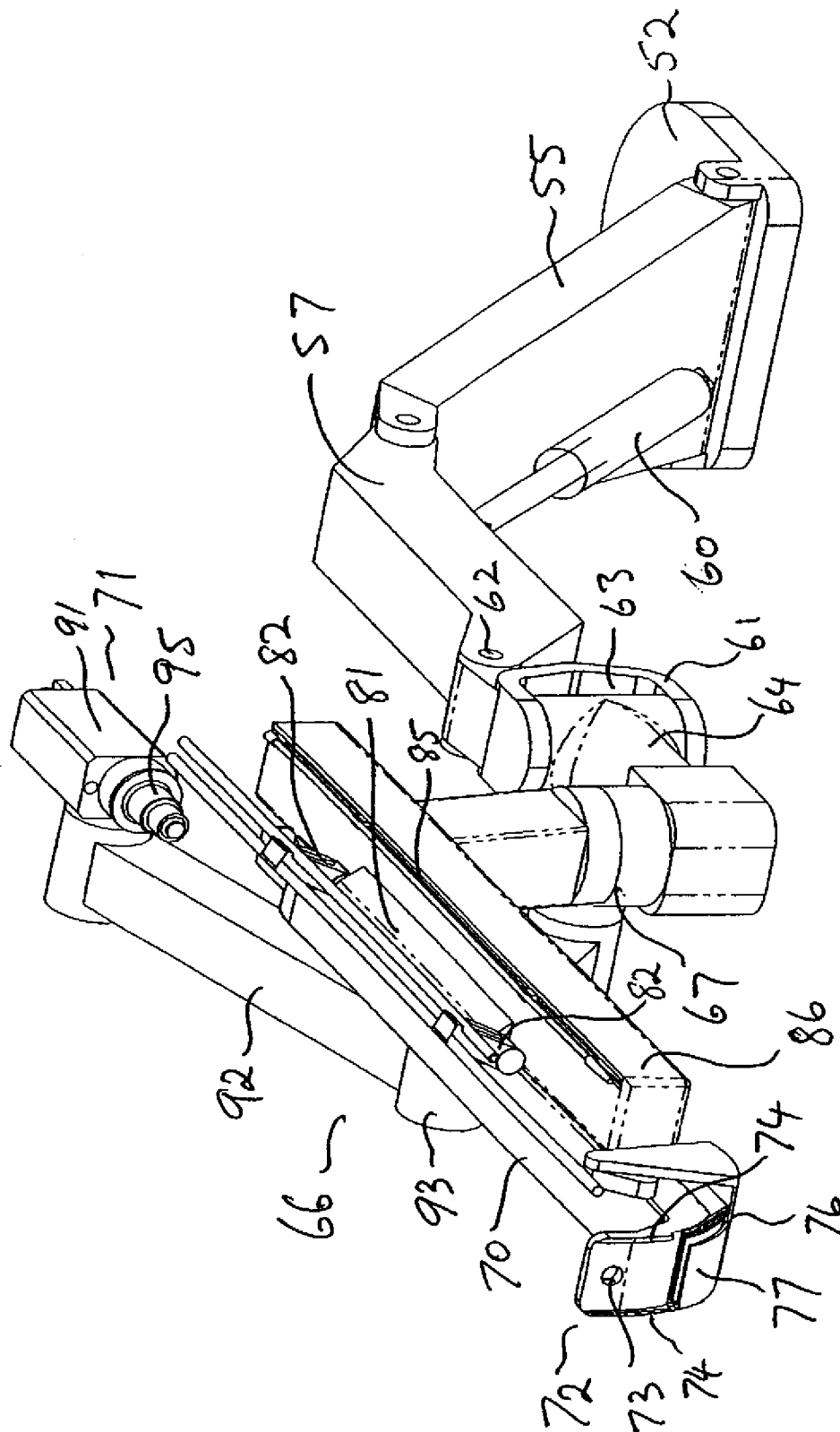


FIG. 5

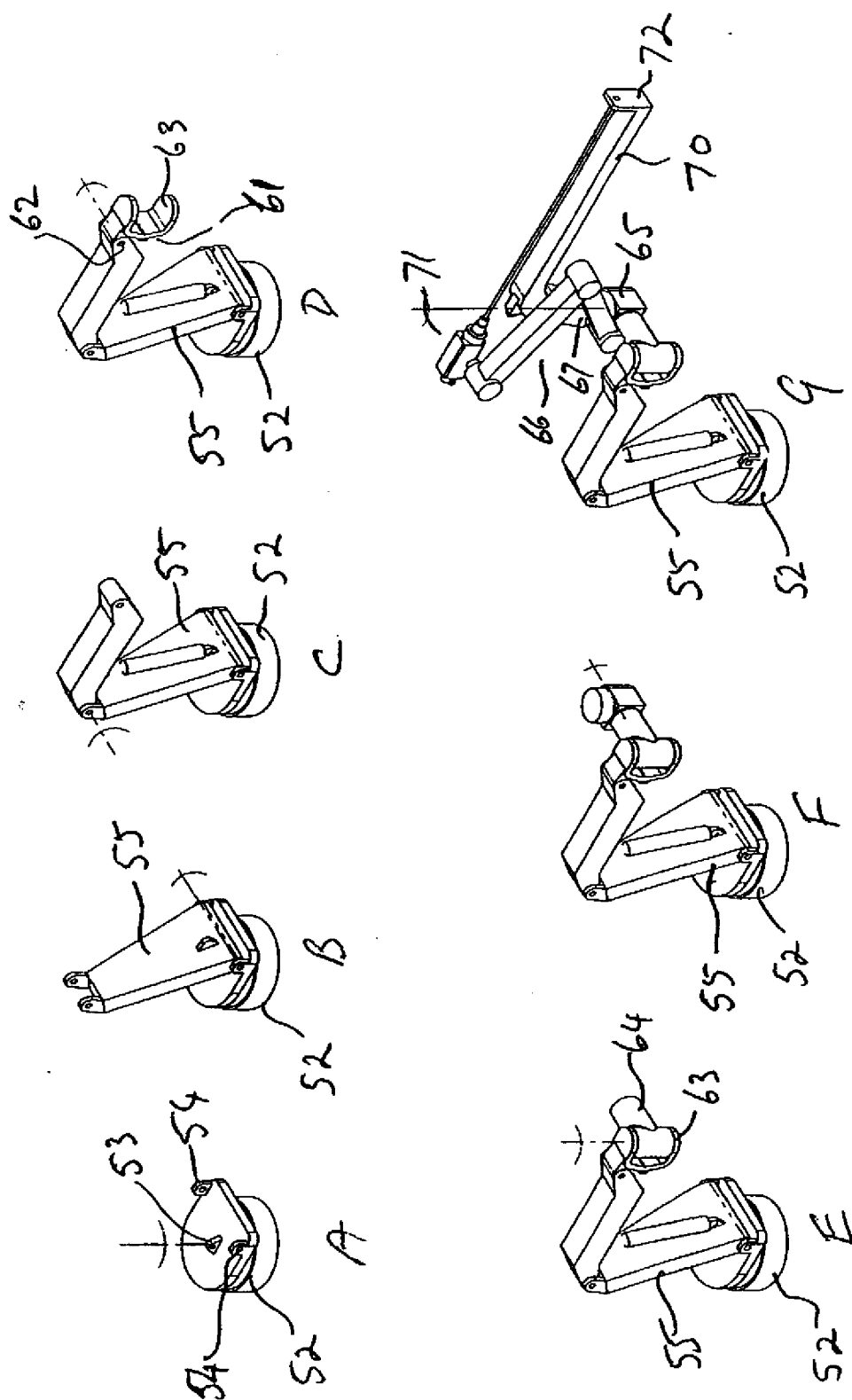


FIG. 6 A-G

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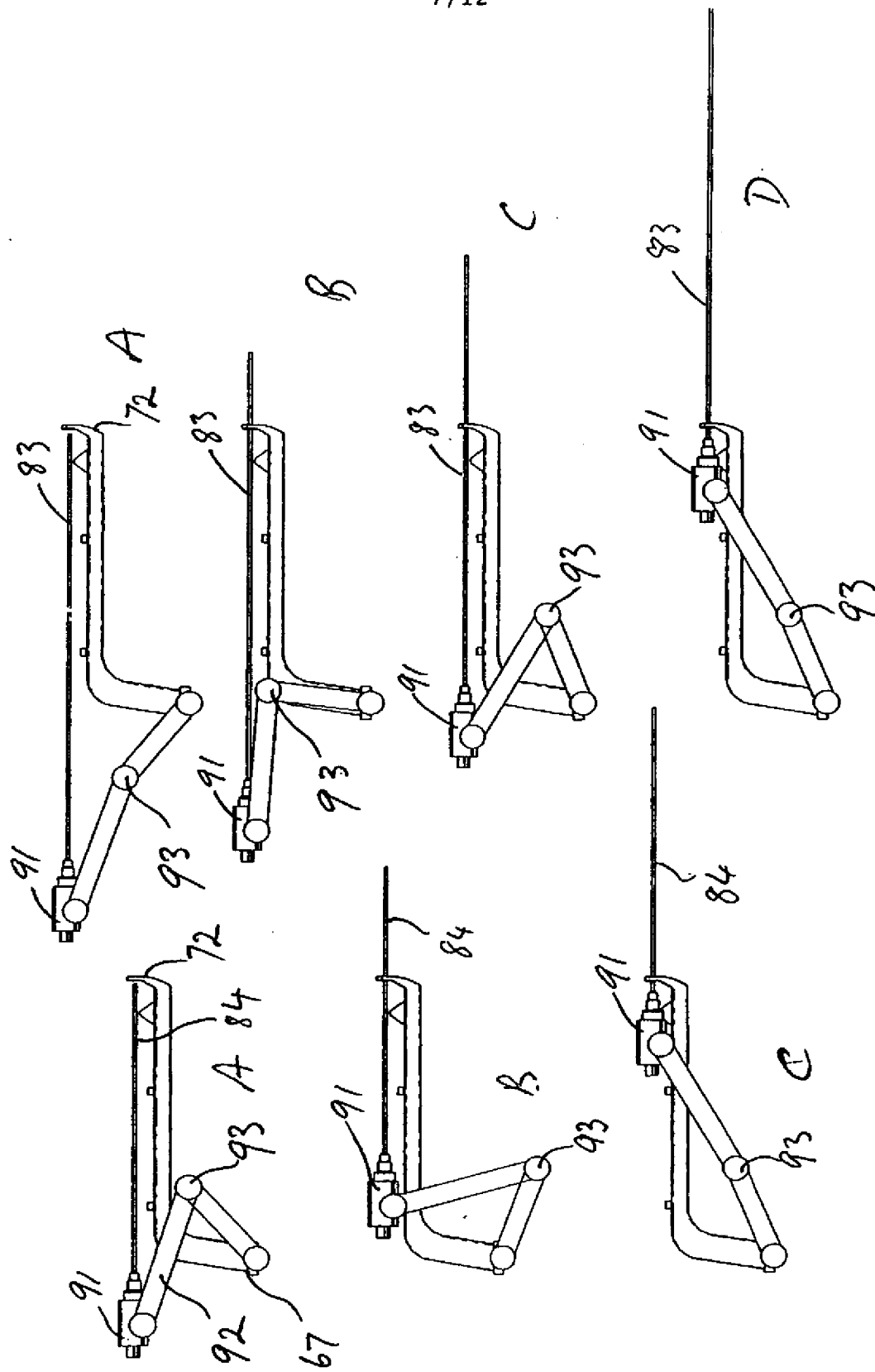
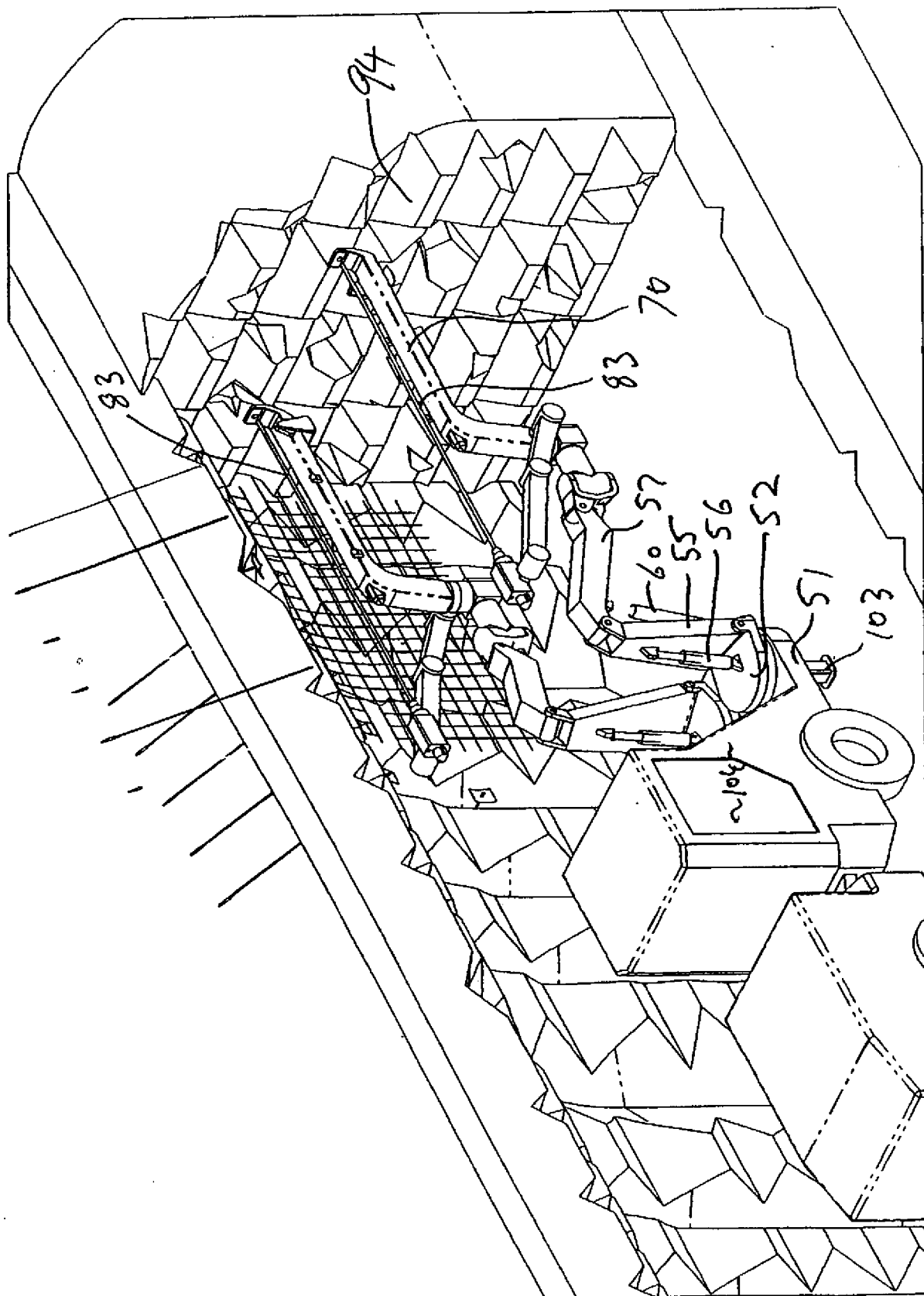


FIG. 8A-D

FIG. 7A-C



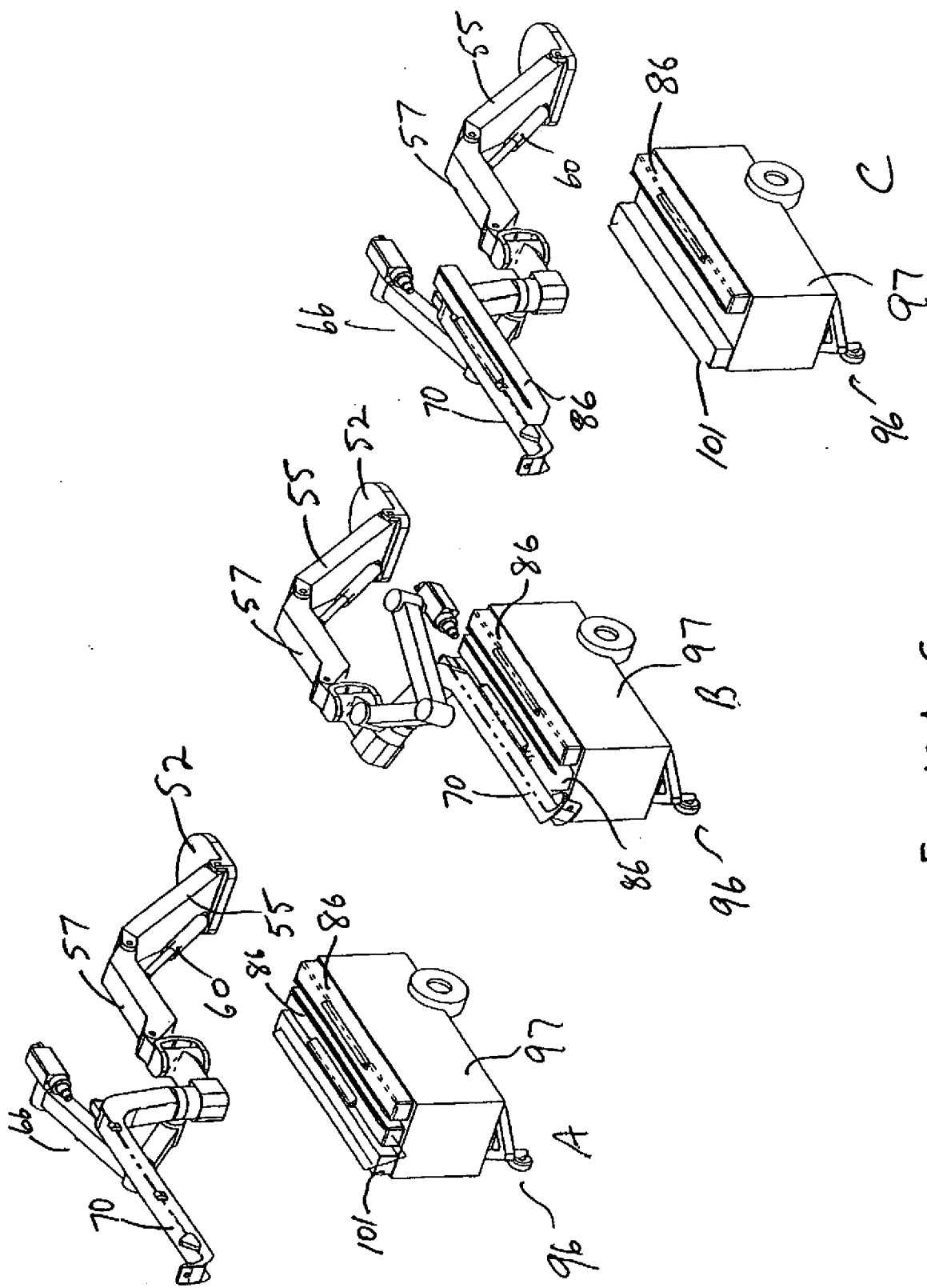
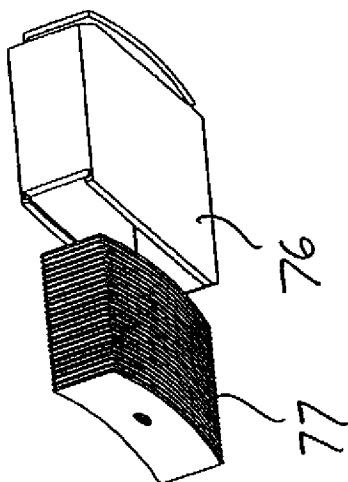
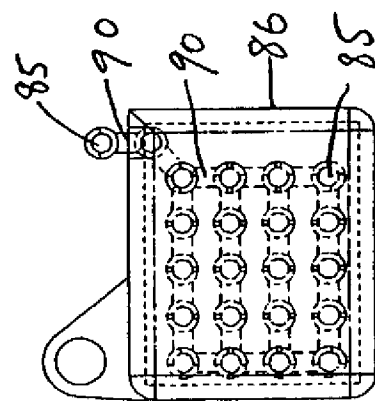
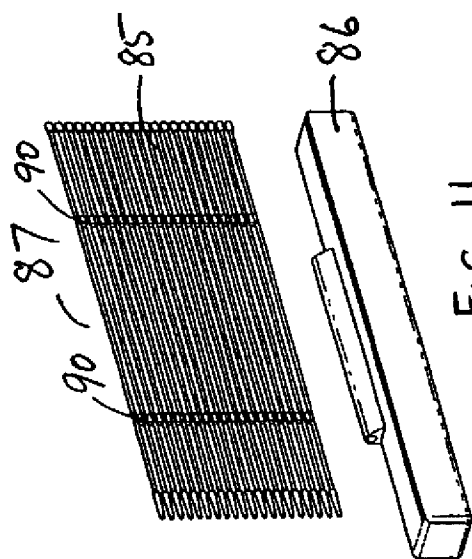


FIG. 10A-C



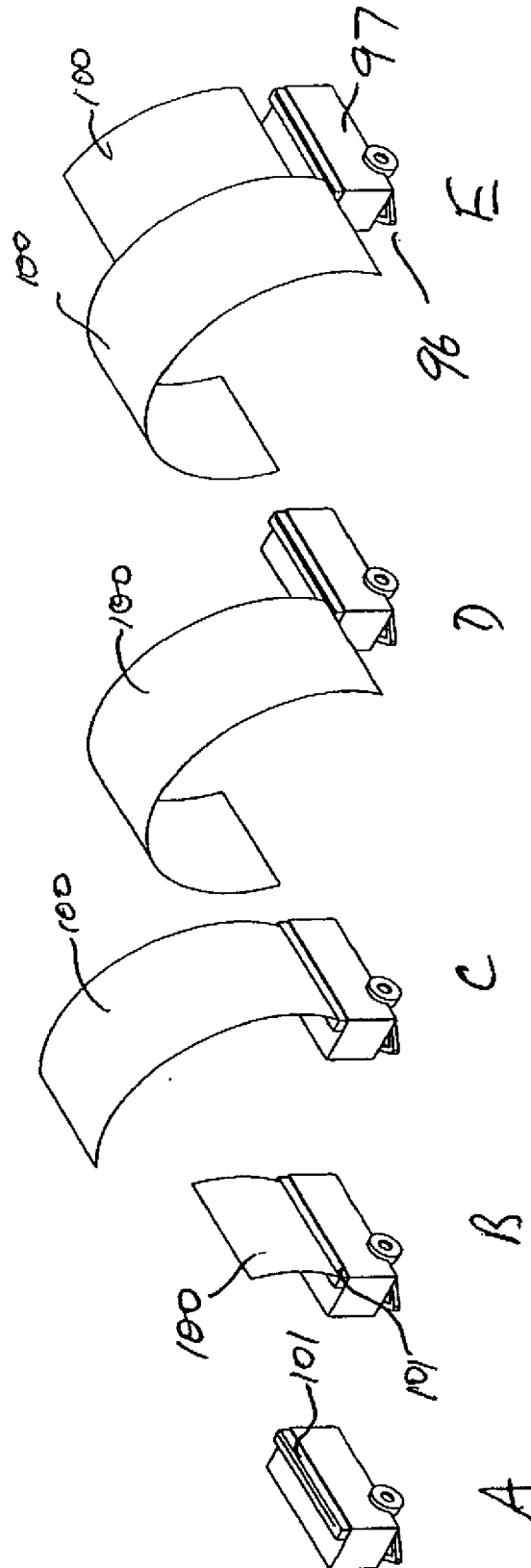


FIG. 14 A-E

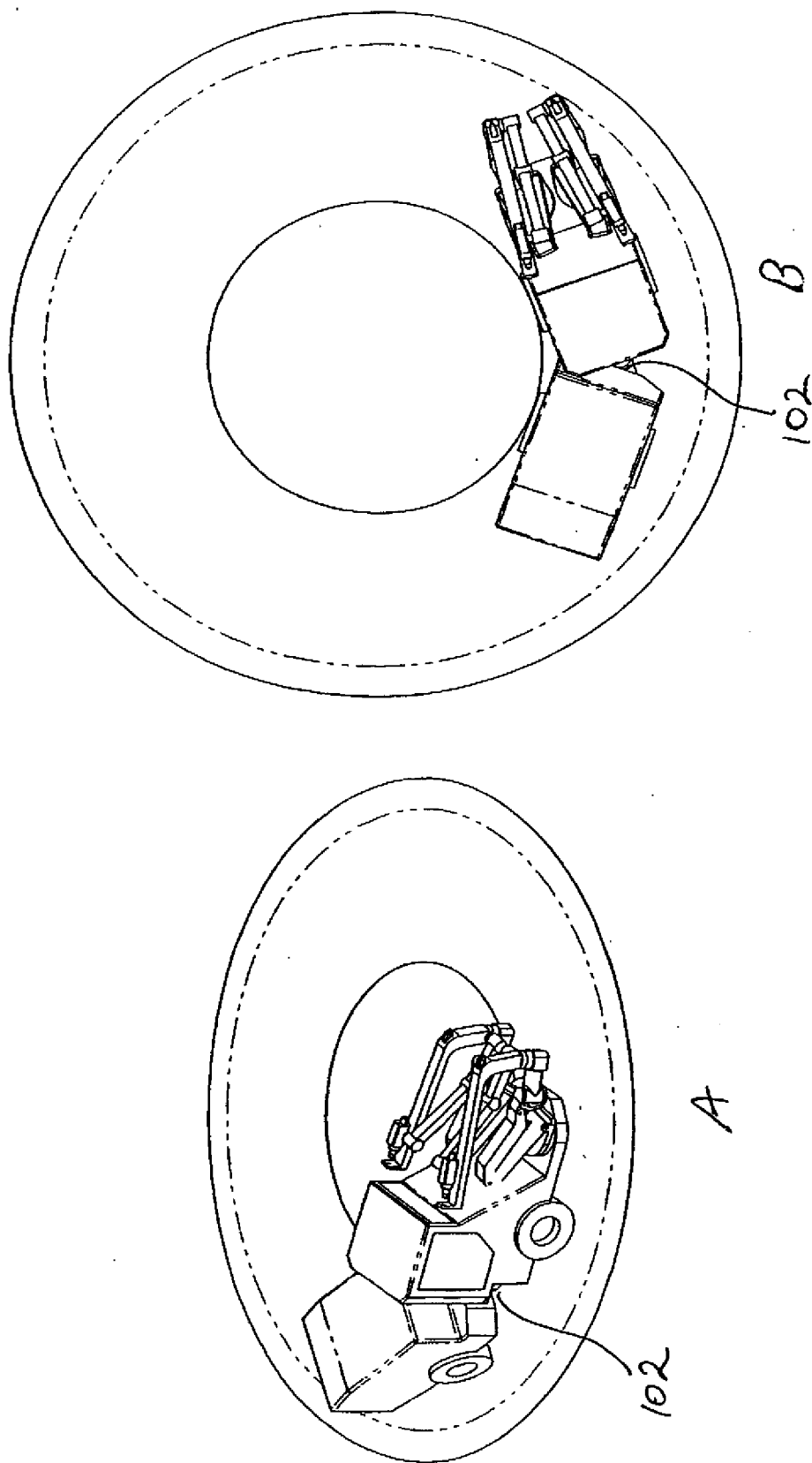


FIG 22A-B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU02/00791

A. CLASSIFICATION OF SUBJECT MATTER		
Int. Cl. ⁷ : E21D 20/00, 21/00, 11/00, 11/14, 11/18, 11/40 E21B 7/02, 15/00		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
IPC E21D 20/00, 21/00, 11/00, 11/14, 11/18, 11/40 E21B 7/02, 15/00, F16B 27/00, B25F 5/00		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
AU: IPC AS ABOVE		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
WPAT: boom+ or arm+ or plac+ or pivot+ or link+ or magazine+ or belt+ or bolt+ or mesh+ or grid+ or wire+ or net+ or fabric+		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 00/60211 A1 (CHRISTOS) 12 October 2000 Figures 1 and 2	1-3
A	EP 379187 A (BAUER SPEZIALTIEFBAU GMBH) 25 July 1990 Figure 2	1-3
A	AU 35788/99 A1 (HYDRO POWER ENGINEERING (PROPRIETARY) LIMITED et al) 13 January 2000 The whole document	1-3
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family	
Date of the actual completion of the international search 19 July 2002		Date of mailing of the international search report 25 JUL 2002
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustalia.gov.au Facsimile No. (02) 6285 3929		Authorized officer LEOPOLD FILIPOVIC Telephone No : (02) 6283 2105

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU02/00791

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5720582 A (MORRISON et al) 24 February 1998 The whole document	4-10
Y	AU 61277/2000 A1 (ISHIKAWAJIMA-HARIMA HEAVY INDUSTRIES CO., LTD.) 29 March 2001 The whole document	4-10
Y	US 6036013 A (CHEN) 14 March 2000 The whole document	4-10
Y	US 5544746 A (DOHI) 13 August 1996 The whole document	4-10
Y	DE 29920176 U1 (ZAHN HARALD GMBH) 10 February 2000 The whole document	4-10
X	US 5816750 A (STEFFENINO) 6 October 1998 The whole document	11-14
X	US 4196935 A (DRING) 8 April 1980 The whole document	11-14
X	US 4251168 A (GROETSCHER) 17 February 1981 The whole document	11-14
A	Derwent Abstract Accession No. 90-020558/03, Class Q49, SU 1469149 A (MOSC MOSINZHPROEKT) 30 March 1989	11-14

INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU02/00791

Box I Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos :
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos :
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos :
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box II Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. Claims 1-3,
 2. Claims 4-10,
 3. Claims 11-14, for the reasons indicated on an extra sheet.
1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims
 2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
 3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
 4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

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Supplemental Box

(To be used when the space in any of Boxes I to VIII is not sufficient)

Continuation of Box No: II

The international application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept. In coming to this conclusion the International Searching Authority has found that there are different inventions as follows:

1. Claims 1-3 are directed to an articulated boom arm. It is considered that a pivoted link arrangement between the first member, the first and second pivoted links such that the drill is reciprocally linearly movable along the first member comprises a first "special technical feature".
2. Claims 4-10 are directed to a magazine system for elongate rock bolts. It is considered that the feature of at least one belt having a plurality of spaced receptors accommodating the bolts and a housing having a length exceeding the length of the bolts comprises a second "special technical feature".
3. Claims 11-14 are directed to a dispensing device for steel reinforcing mesh and a method of applying steel reinforcing mesh. It is considered that the feature of at least partially straightening the length of mesh to increase its radius of curvature and then cutting the straightened mesh to suit the peripheral dimensions of the tunnel or drive comprises a third "special technical feature".

Since the above-mentioned groups of claims do not share any of the technical features identified, a "technical relationship" between the inventions, as defined in PCT rule 13.2 does not exist. Accordingly the international application does not relate to one invention or to a single inventive concept, a priori.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/AU02/00791

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member			
WO	00/60211	AU	35717/00		
EP	379187	AT	76459	DE	3901664
		KR	9514369	PT	92887
AU	35788/99	ZA	9904043		
US	5720582	NONE			
AU	61277/00	NONE			
US	6036013	NONE			
US	5544746	JP	6267032	DE	69404014
				EP	648579
DE	29920176	NONE			
US	5816750	AU	39878/97		
US	4196935	DE	2847546	GB	2030615
US	4251168	US	4122682	DE	2748032
		GB	1595369	JP	54026903
		PL	119788	AU	27521/77
		CA	1072352	CA	1072353
		GB	1592193	AT	5054/77
		DE	2634557	FR	2360747
		GB	1595370	ZA	7704601
		ES	467983		
				ES	467984
				PL	205414
				AU	518551
				DE	2656760
				AT	354962
				GB	1592194
				DE	2734949

END OF ANNEX

